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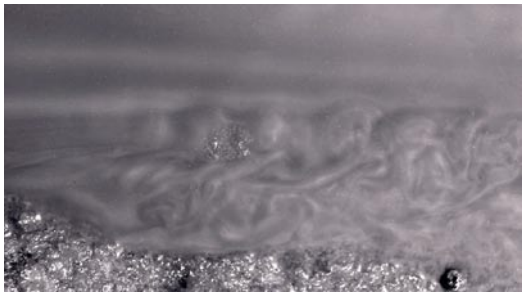
MCEN 5228
Group 2 – Turbulent Laminar Interface

The purpose of this image is to show some readers that paying attention to their environment can open up a world of fluid dynamics that previously they had not seen before. Captured in this image is a very visible demonstration of one flow having coexisting states next to each other. The laminar flow across the top of the image is running alongside first the transitional flow then downstream alongside the turbulent flow. This can happen because of the difference in viscous stresses or velocity between the two regions. The lower region is in a transitional and turbulent state because of the roughness of the shallow surface below and behind the region of interest. This roughness created pressure differences around the surrounding area, forcing non-zero stresses on the surrounding fluid and altering the velocities in order to conserve mass and momentum.

This image was captured in a parking lot during a heavy snow melting day. Water mixed with dirt flowed through eroded channels towards sewage holes around the parking lot. This particular image spans approximately 1'-1.5' across and < 1' in height. Rough boundaries along the bottom formed by dirt and ice instigated the transitional and turbulent flow. Due to the several flow states in this image, they Reynolds number varies from < 3000 in the laminar flow to > 3000 for the transitional and turbulent flow. The upper limits of the Reynolds number are unsure.

Visualization for this image was one of the main reasons for taking this image. The sun light would reflect off the mixed dirt particles flowing in the melted snow. These reflections allowed easy visualization of the flow occurring because each particle would align with the flow direction.

Details of the camera settings are as follow:
Camera Type: Casio EX-Z700 (Digital)
Focal Length: 13 mm
Size (Pixels): 3072 x 2304
F-Number: F/4.1
Shutter Speed: 1/400 sec



Small modifications were made to the original image via Photoshop. The image was cropped and rotated 180^{o} to highlight important features within the original image and orient the flow in a traditional left to right flow pattern. The original image was also very bright, so an adjustment of the levels helped to bring out important features of the flow. Several spots/impurities were removed from the image that was considered distracting. These spots were either small pieces of ice or bubbles on the surface of the fluid.

What truly captured the photographer's attention when coming across this phenomenon was how such a beautiful thing happens naturally under our feet. Physically, this image is perfect; there is a clear separation between the laminar flow and other flows regions. Artistically, the image may be lacking to some in appeal, maybe needing more color or

something extra that gives it more of a pop. The photographer, while understanding the majority of the physics revealed here, is somewhat unclear on some details, such as how the dense dirt was able to float in the water for such extended periods of time. Extensions onto this theme would be to capture the transition from turbulent back to laminar flow that occurs downstream. Attempts of this were made, but became difficult to capture all the details of the smaller scale turbulence occurring.

Kundu, P., Cohen, I., Fluid Mechanics – Third Edition, Elsevier Inc. 2004
Pope, S., Turbulent Flows, Cambridge 2000